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ENEE 610

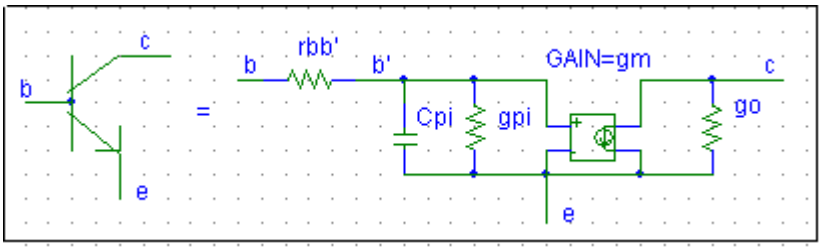
Problems for grading, Set 3

Due at class M 09/29/03

Some 2-Port Theory and State Equations

1. (35 points)

The following three-terminal 2-port, drawn using PSpice schematic components, is the standard hybrid-pi equivalent circuit for the BJT as shown (where the parameters are defined via the bias collector current Ic, thermal voltage VT=kT/q [=26mv at room T], transistor dc beta, and forward Early voltage VA as gm=Ic/VT=transconductance, go=Ic/VA=output conductance, gpi=gm/beta=base-emitter diode conductance. Also rbb' is the base spreading resistance and Cpi the base-emitter diode capacitance)



a) Find the admittance matrix Y(s) using the symbols of the schematic. Use v1=vbe, v2=vce, i1=ib, i2=ic as the port variables.

b) For Ic=2mA, VA=100v, beta=50, rbb'=10Ohm, and Cpi=20pF, evaluate Y(s) at room temperature.

c) For the conditions of b) evaluate both the Hermitian part and the real part of Y(s) in Re(s)>0.

d) Why is this transistor equivalent circuit not passive when a transistor is just a connection of inert material?

2. (35 points).

For the driving point impedance

$$z(s) = \frac{2s(s+2)}{(s+8)(s^2+25)}$$

a) Give a set of state variable equations dx/dt=Ax+Bu, y=Cx+Du with u-i, y=v .

c) Draw a PSpice schematic for the state variable equations of a) using capacitors to give the derivatives and G components for the other terms.

d) Run Spice when u=3cos(5t) with x(0)-0 and plot y for t between 0 and 2 seconds.